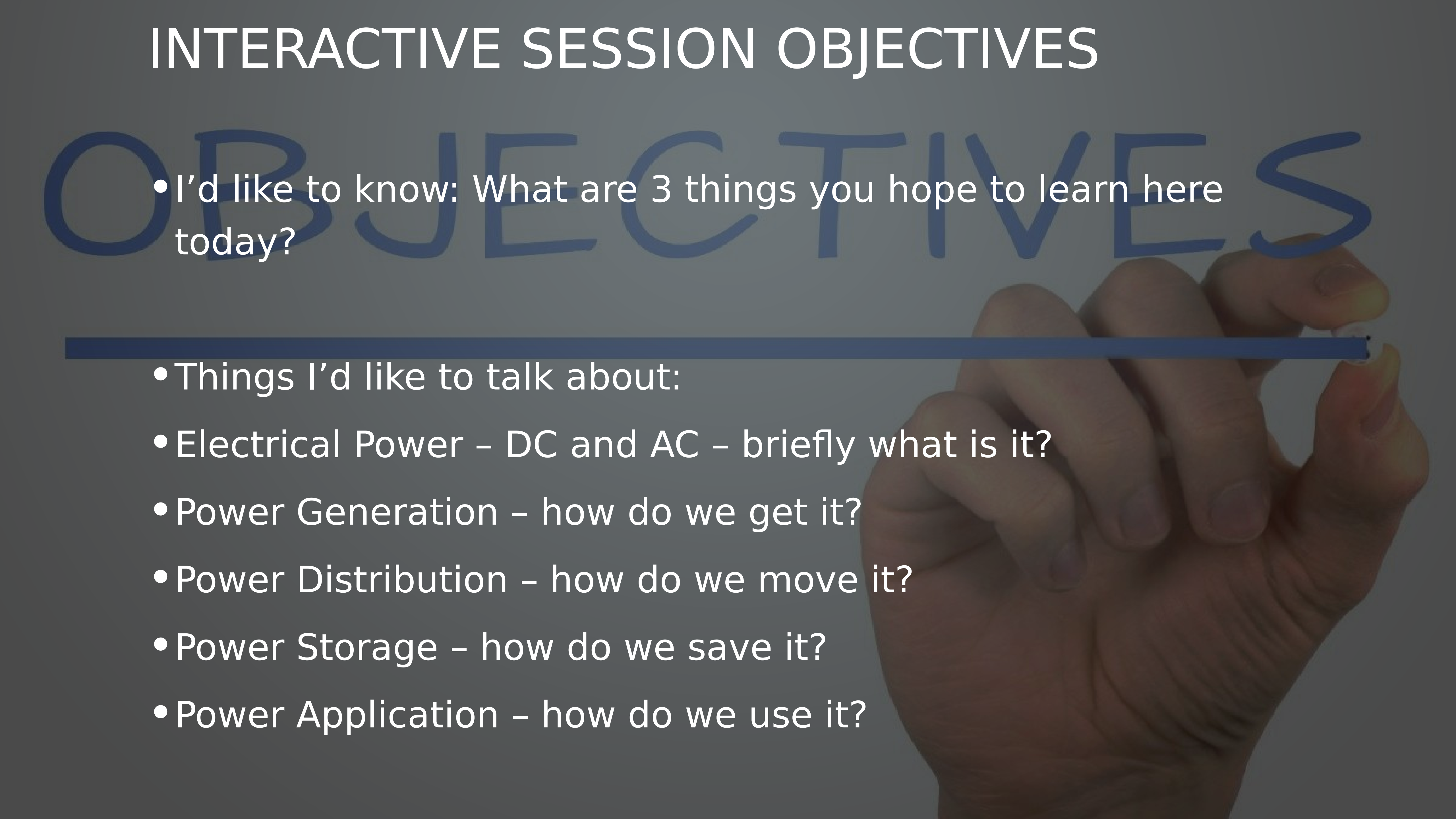
MAY THE ELECTROMOTIVE FORCE BE WITH YOU!

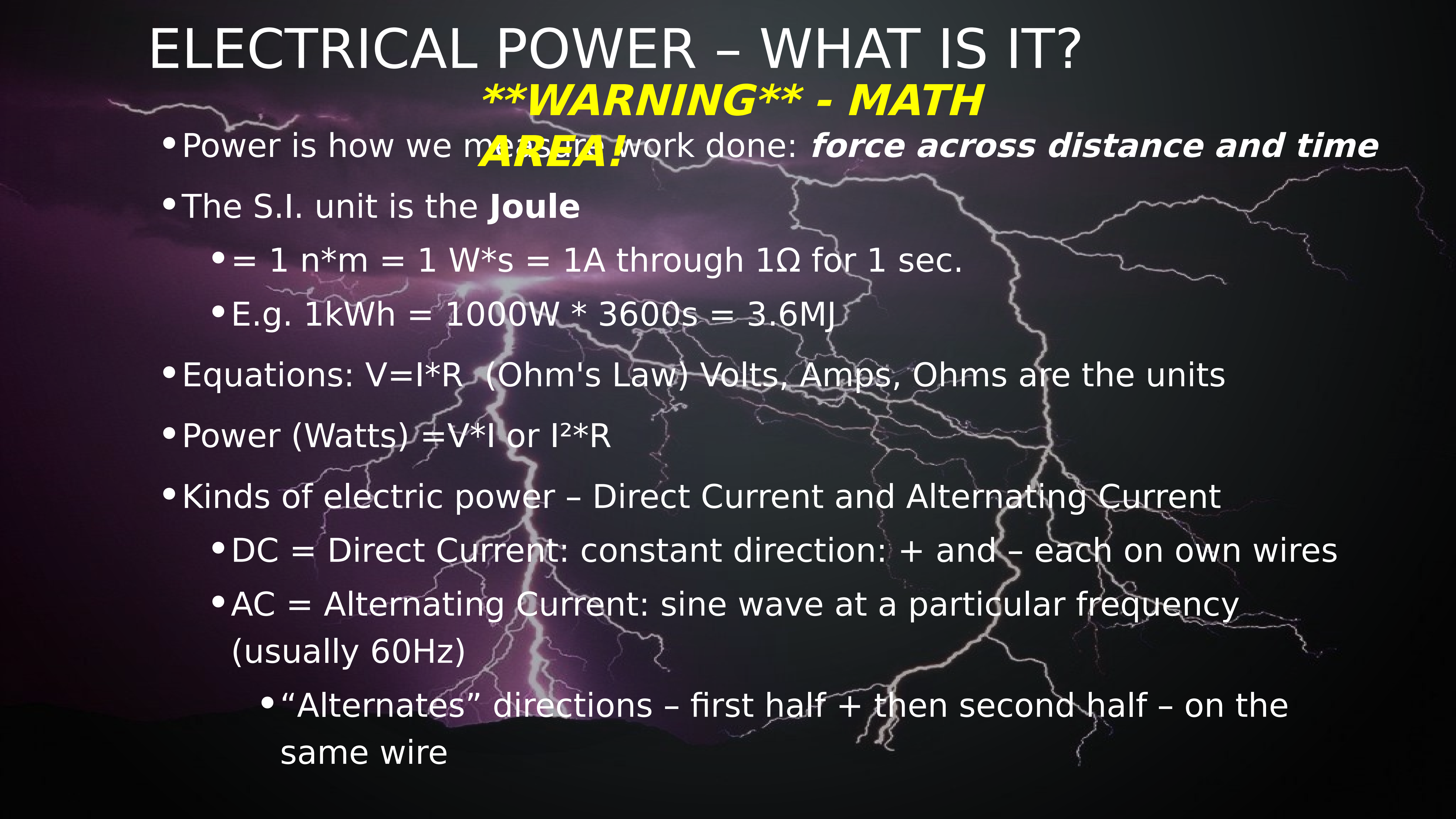
THE POWER TO COMMUNICATE

INTERACTIVE SESSION OBJECTIVES



- I’d like to know: What are 3 things you hope to learn here today?

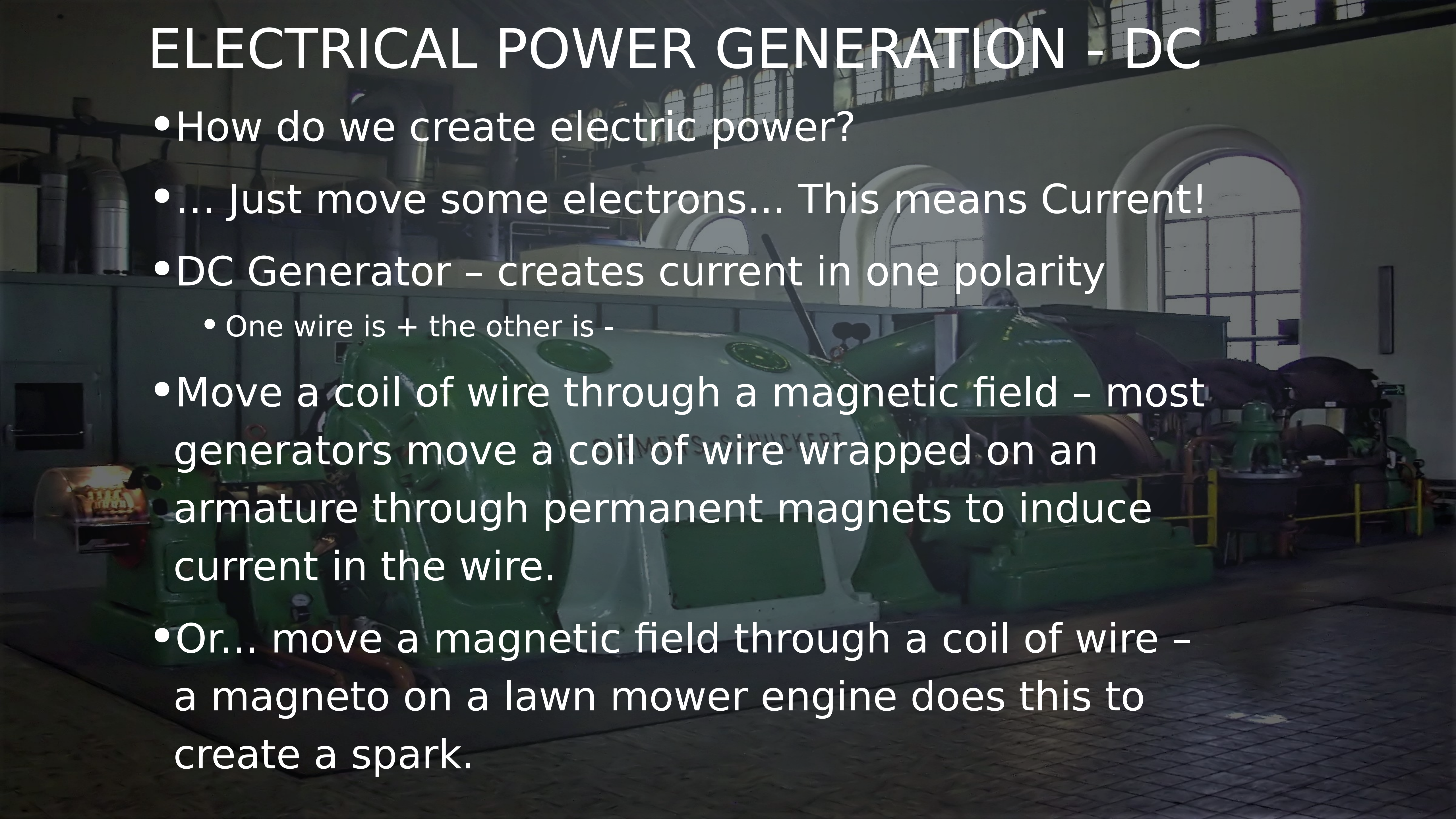
- Things I’d like to talk about:
- Electrical Power – DC and AC – briefly what is it?
- Power Generation – how do we get it?
- Power Distribution – how do we move it?
- Power Storage – how do we save it?
- Power Application – how do we use it?



ELECTRICAL POWER – WHAT IS IT?

***WARNING** - MATH AREA!*

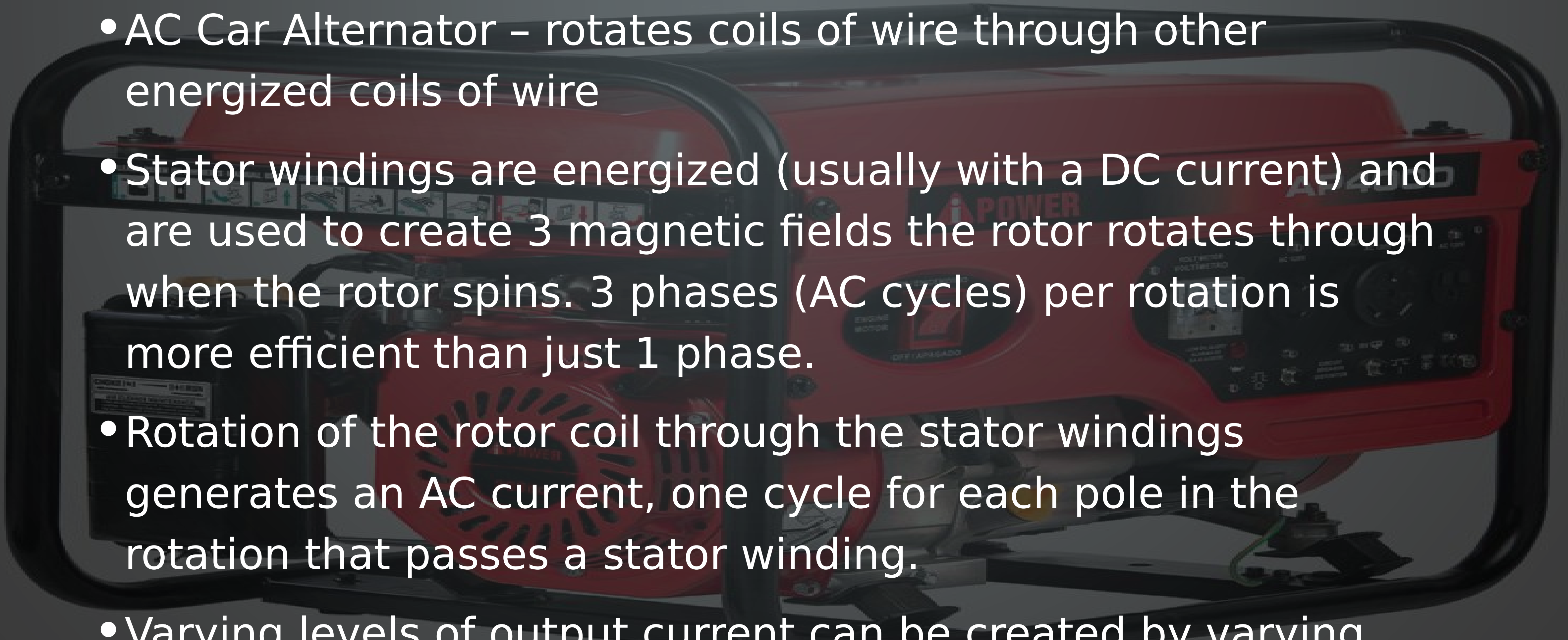
- Power is how we measure work done: ***force across distance and time***
- The S.I. unit is the **Joule**
  - = 1 n*m = 1 W*s = 1A through 1Ω for 1 sec.
  - E.g. 1kWh = 1000W * 3600s = 3.6MJ
- Equations: $V=I*R$ (Ohm's Law) Volts, Amps, Ohms are the units
- Power (Watts) =$V*I$ or I^2*R
- Kinds of electric power – Direct Current and Alternating Current
  - DC = Direct Current: constant direction: + and – each on own wires
  - AC = Alternating Current: sine wave at a particular frequency (usually 60Hz)
    - “Alternates” directions – first half + then second half – on the same wire



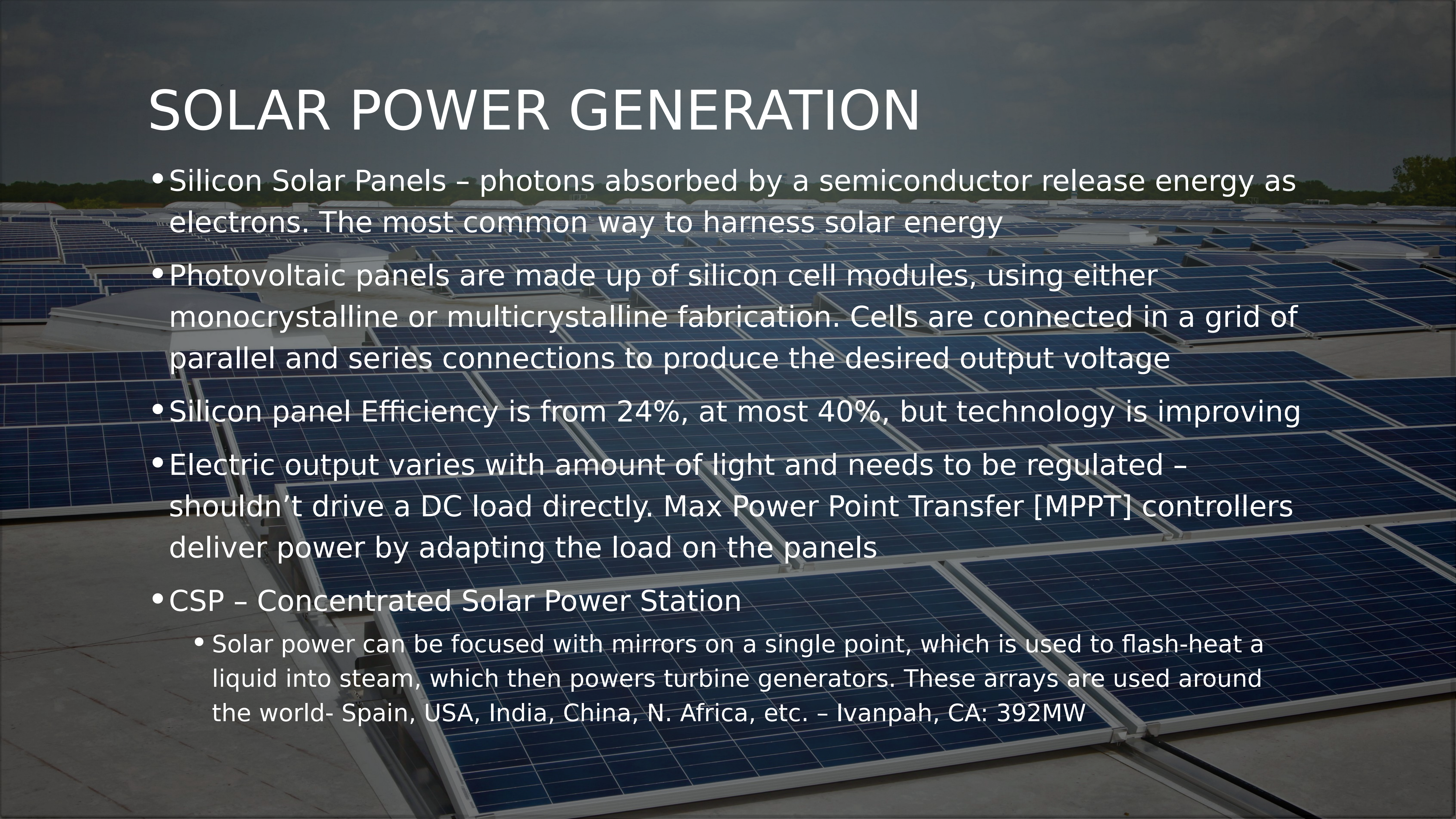
ELECTRICAL POWER GENERATION - DC

- How do we create electric power?
- … Just move some electrons… This means Current!
- DC Generator – creates current in one polarity
  - One wire is + the other is -
- Move a coil of wire through a magnetic field – most generators move a coil of wire wrapped on an armature through permanent magnets to induce current in the wire.
- Or… move a magnetic field through a coil of wire – a magneto on a lawn mower engine does this to create a spark.

AC POWER GENERATION



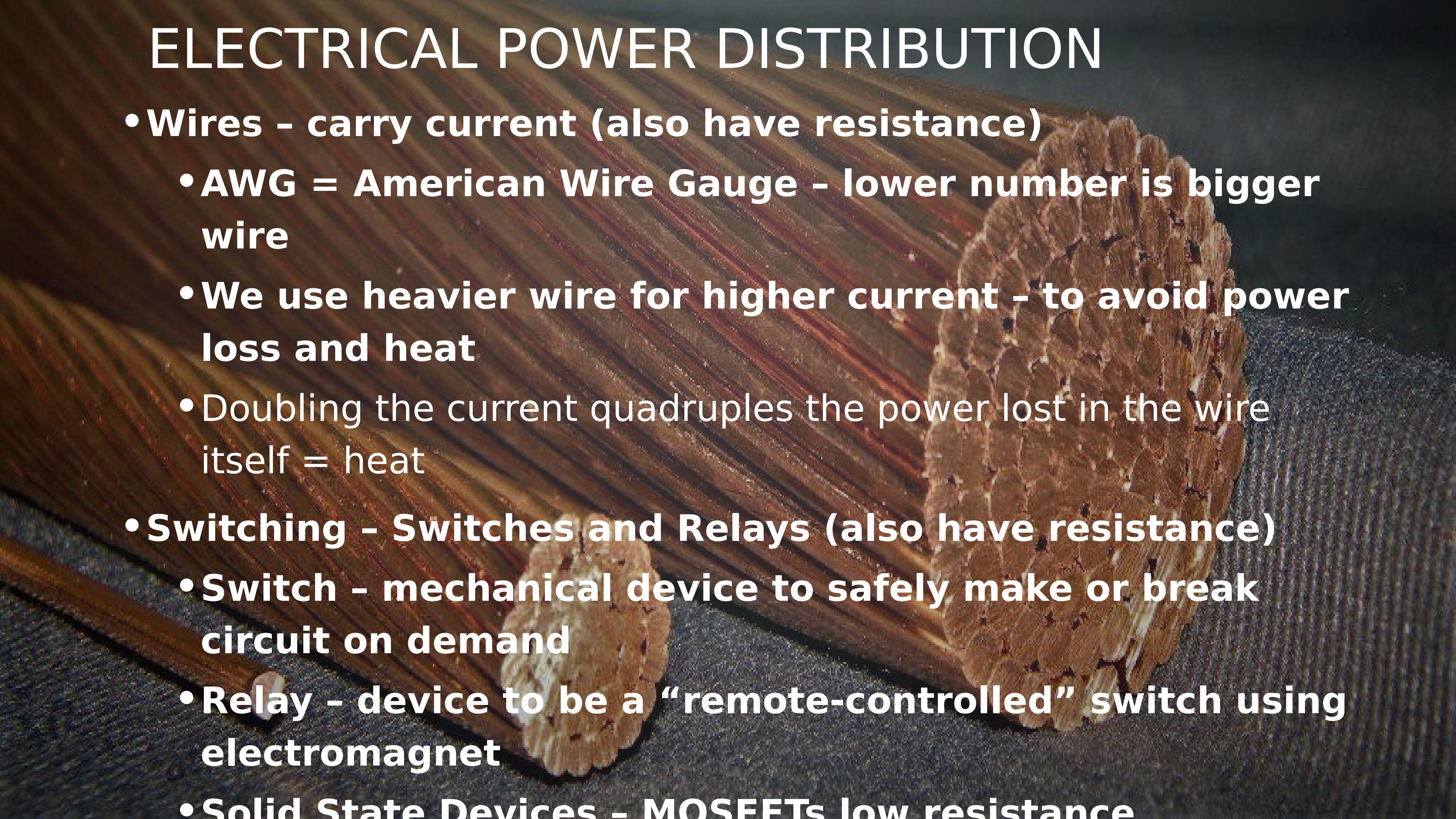
- AC Car Alternator – rotates coils of wire through other energized coils of wire
- Stator windings are energized (usually with a DC current) and are used to create 3 magnetic fields the rotor rotates through when the rotor spins. 3 phases (AC cycles) per rotation is more efficient than just 1 phase.
- Rotation of the rotor coil through the stator windings generates an AC current, one cycle for each pole in the rotation that passes a stator winding.
- Varying levels of output current can be created by varying the strength of the magnetic field in the stator with more or less power from the battery.



SOLAR POWER GENERATION

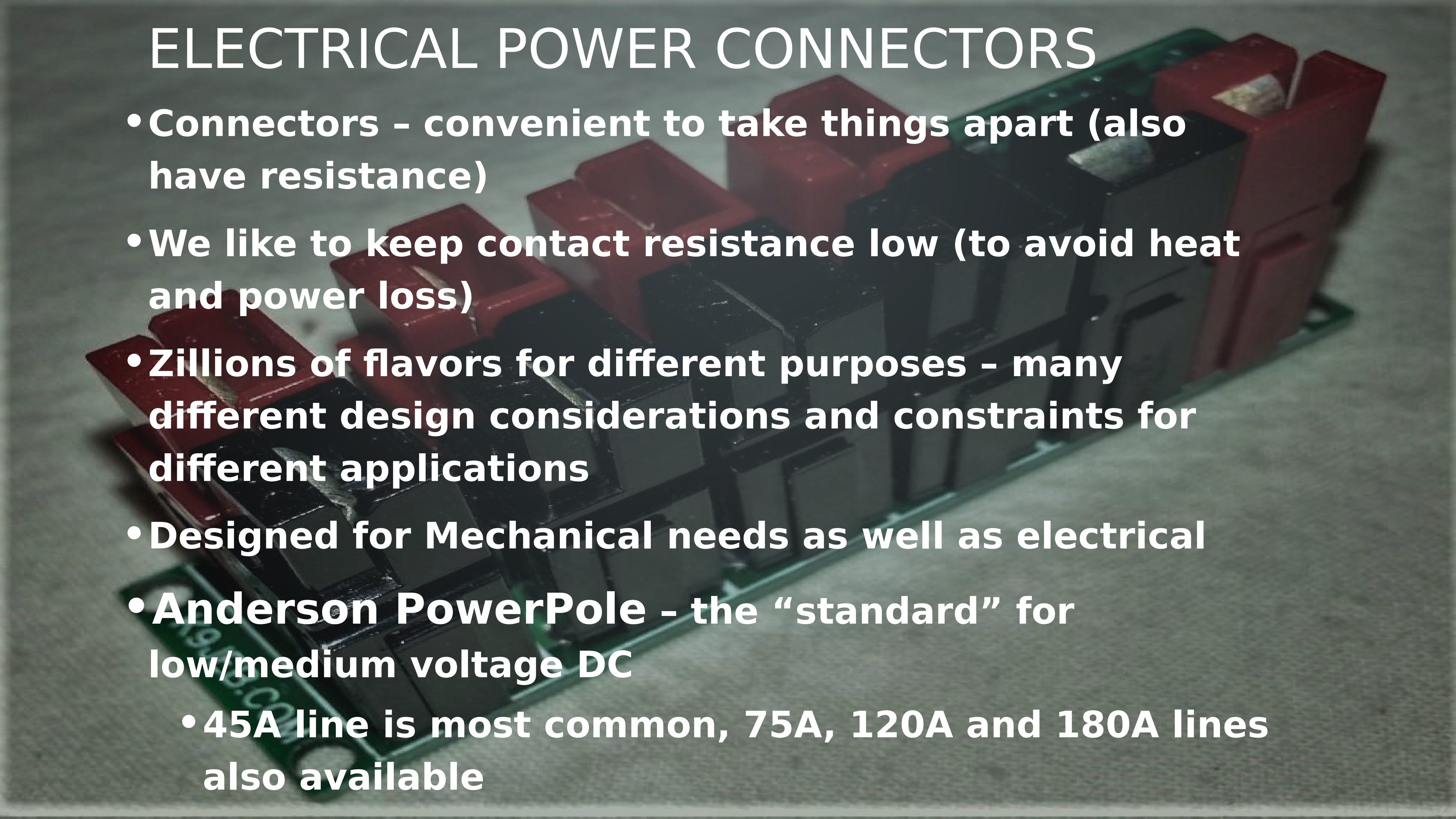
- Silicon Solar Panels – photons absorbed by a semiconductor release energy as electrons. The most common way to harness solar energy
- Photovoltaic panels are made up of silicon cell modules, using either monocrystalline or multicrystalline fabrication. Cells are connected in a grid of parallel and series connections to produce the desired output voltage
- Silicon panel Efficiency is from 24%, at most 40%, but technology is improving
- Electric output varies with amount of light and needs to be regulated – shouldn’t drive a DC load directly. Max Power Point Transfer [MPPT] controllers deliver power by adapting the load on the panels
- CSP – Concentrated Solar Power Station
  - Solar power can be focused with mirrors on a single point, which is used to flash-heat a liquid into steam, which then powers turbine generators. These arrays are used around the world- Spain, USA, India, China, N. Africa, etc. – Ivanpah, CA: 392MW

ELECTRICAL POWER DISTRIBUTION



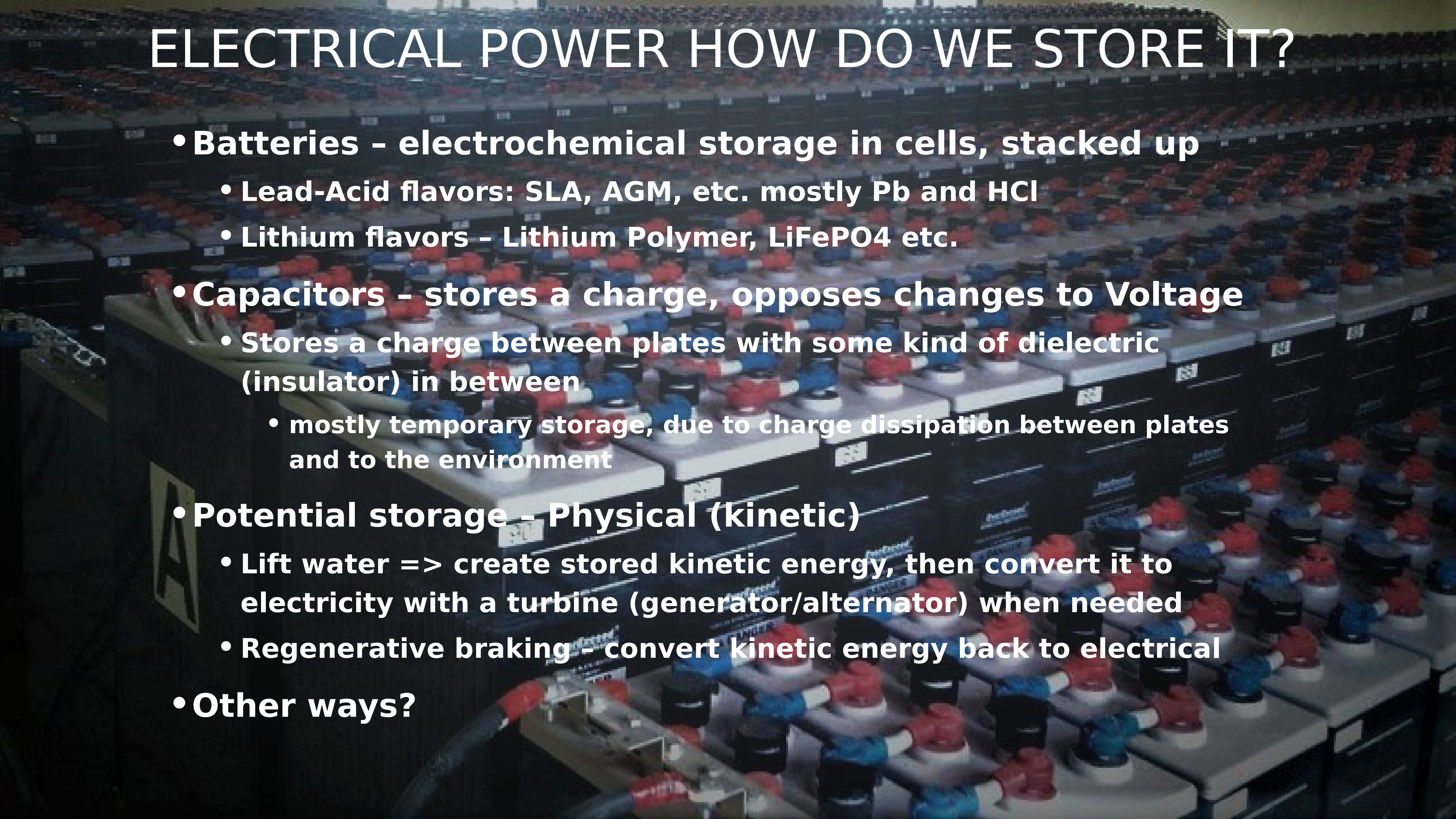
- **Wires – carry current (also have resistance)**
  - **AWG = American Wire Gauge – lower number is bigger wire**
  - **We use heavier wire for higher current – to avoid power loss and heat**
  - Doubling the current quadruples the power lost in the wire itself = heat
- **Switching – Switches and Relays (also have resistance)**
  - **Switch – mechanical device to safely make or break circuit on demand**
  - **Relay – device to be a “remote-controlled” switch using electromagnet**
  - **Solid State Devices – MOSFETs low resistance**

ELECTRICAL POWER CONNECTORS

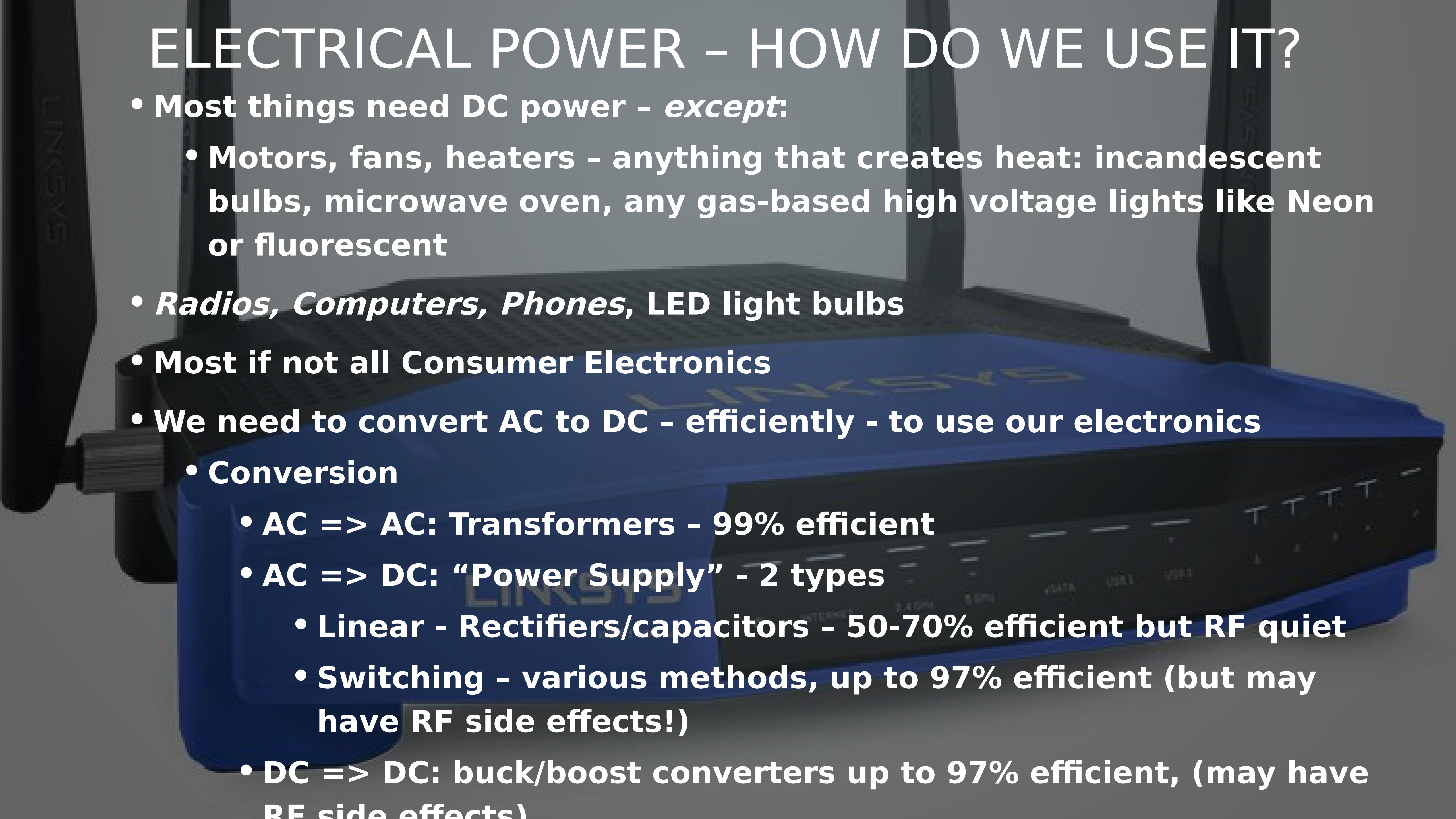


- **Connectors – convenient to take things apart (also have resistance)**
- **We like to keep contact resistance low (to avoid heat and power loss)**
- **Zillions of flavors for different purposes – many different design considerations and constraints for different applications**
- **Designed for Mechanical needs as well as electrical**
- **Anderson PowerPole – the “standard” for low/medium voltage DC**
  - **45A line is most common, 75A, 120A and 180A lines also available**

ELECTRICAL POWER HOW DO WE STORE IT?



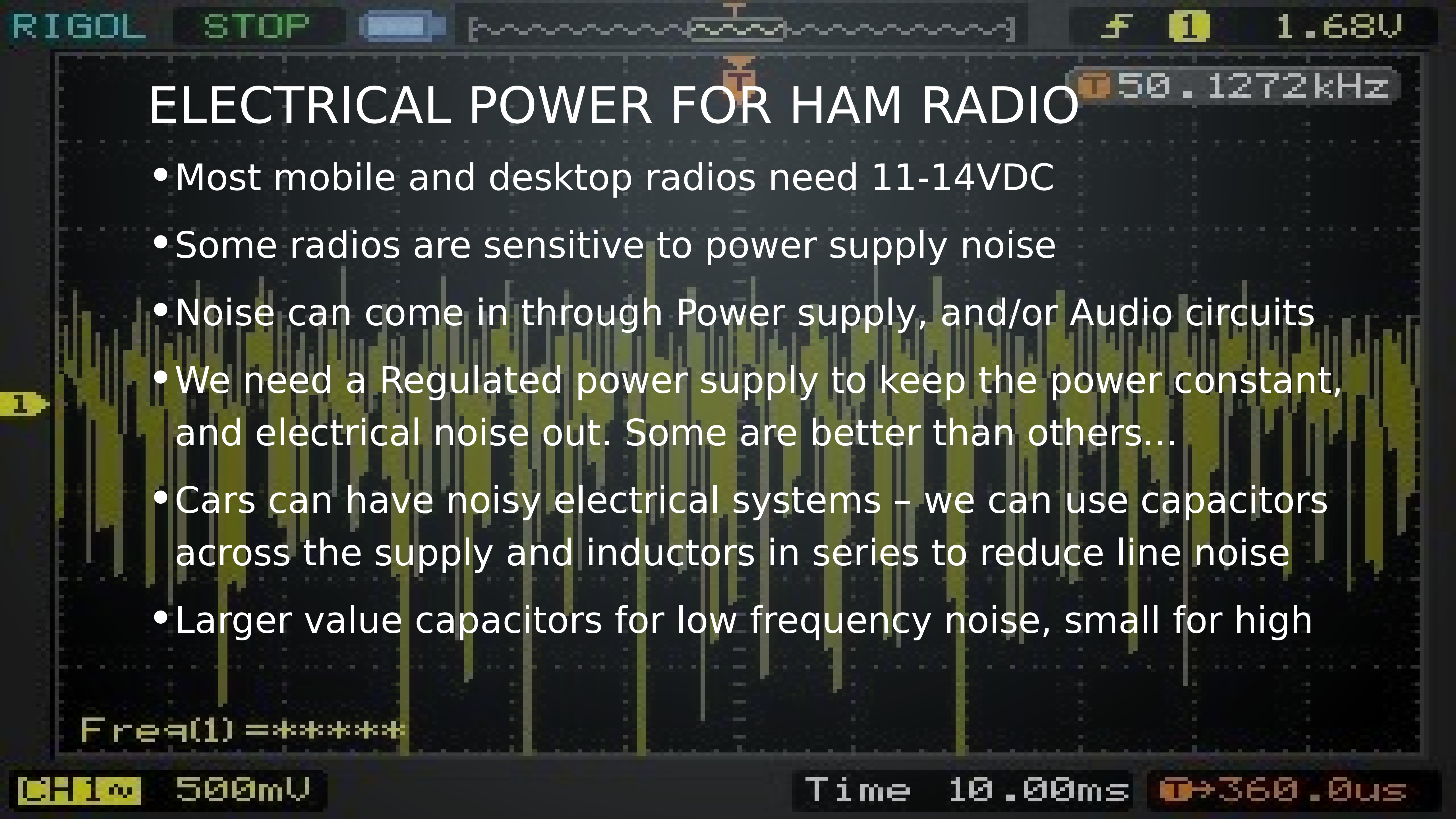
- **Batteries – electrochemical storage in cells, stacked up**
  - **Lead-Acid flavors: SLA, AGM, etc. mostly Pb and HCl**
  - **Lithium flavors – Lithium Polymer, LiFePO4 etc.**
- **Capacitors – stores a charge, opposes changes to Voltage**
  - **Stores a charge between plates with some kind of dielectric (insulator) in between**
    - **mostly temporary storage, due to charge dissipation between plates and to the environment**
- **Potential storage – Physical (kinetic)**
  - **Lift water => create stored kinetic energy, then convert it to electricity with a turbine (generator/alternator) when needed**
  - **Regenerative braking – convert kinetic energy back to electrical**
- **Other ways?**



ELECTRICAL POWER – HOW DO WE USE IT?

- **Most things need DC power – *except*:**
  - **Motors, fans, heaters – anything that creates heat: incandescent bulbs, microwave oven, any gas-based high voltage lights like Neon or fluorescent**
- ***Radios, Computers, Phones*, LED light bulbs**
- **Most if not all Consumer Electronics**
- **We need to convert AC to DC – efficiently - to use our electronics**
  - **Conversion**
    - **AC => AC: Transformers – 99% efficient**
    - **AC => DC: “Power Supply” - 2 types**
      - **Linear - Rectifiers/capacitors – 50-70% efficient but RF quiet**
      - **Switching – various methods, up to 97% efficient (but may have RF side effects!)**
    - **DC => DC: buck/boost converters up to 97% efficient, (may have RF side effects)**

ELECTRICAL POWER FOR HAM RADIO



- Most mobile and desktop radios need 11-14VDC
- Some radios are sensitive to power supply noise
- Noise can come in through Power supply, and/or Audio circuits
- We need a Regulated power supply to keep the power constant, and electrical noise out. Some are better than others…
- Cars can have noisy electrical systems – we can use capacitors across the supply and inductors in series to reduce line noise
- Larger value capacitors for low frequency noise, small for high

Questions?

Thanks for listening!

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REFERENCES

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K9JEB.com PowerPole Connectors, Kits for Power Distribution

PowerWerx https://powerwerx.com